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RAJARSHI SHAHU COLLEGE OF ENGINEERING
TATHAWADE, PUNE-33
(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

DEPARTMENT OF AUTOMATION AND ROBOTICS

Department of Automation and Robotics
B. Tech Structure
(2019 Pattern)

Dr. A. M. Badadhe	Dr. Ram Joshi	Dr. R. K. Jain
BOS Chairman (A & R)	Dean Academics RSCOE, Pune	Director, RSCOE

DEPARTMENT OF AUTOMATION AND ROBOTICS

Vision:

To become an ecosystem in the domain of Automation and Robotics that develops competent multidisciplinary professionals, researchers and entrepreneurs striving for technology led socio-economic development of the nation.

Mission:

- To impart high quality education through best of the teaching-leaning process by using industry ready curriculum.
- To establish centres of excellence in the area of Automation and Robotics where ideas, innovations and research will synergize.
- To align the practices and initiatives with high ethical standards to meet the needs of the society and at large the nation.

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Program Outcomes (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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Program Specific Outcomes (PSOs)

At the end of this program, students will be able to -

PSO1: To integrate principles of engineering in multidisciplinary approach to find out the solutions for complex engineering problems.

PSO2: To design & develop the Automation & Robotics systems for various applications

PSO3: To make a career in Automation & Robotics through industry, entrepreneurship, research and academia while contributing to the continuous development of individual, organisation, society and nation at large.

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DEPARTMENT OF AUTOMATION AND ROBOTICS

Highlights of the Syllabus

The Curriculum of UG Program of **AUTOMATION AND ROBOTICS** has been designed in association with **Experts from Academics, industries / Corporate & Distinguish Alumni.** Major features of the curriculum are presented in the following diagram.

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Unique Features of the Curriculum

1. **Curriculum centered at Outcome Based Education:**
   The new Curriculum is based on student-centered instruction models that focus on measuring student performance through outcomes. The outcomes include subject knowledge, industry required skills and attitudes.
2. **Emphasize on Fundamentals:**
   The nature of the new curriculum is rigorous and well prescribed so that the students can spend more time on preparation and self-study. The students have to learn core subjects, solve practical based assignments and must attempt periodical quizzes. This will benefit them to grasp and keep a strong hold on fundamentals of Engineering in the most effective way.
3. **Experiential Learning:**
   The curriculum emphasizes on hands-on sessions along with theoretical information. The new curriculum considers Problem Based Learning (PBL) as a teaching pedagogy and includes different subjects that encourage the students for hands on learning through virtual labs, mini-projects, etc. Accordingly, the curriculum maintains good balance between theory and laboratory credits.
4. **Promote Creativity and Innovation:**
   Along with experiential learning, the curriculum also motivates the students to inculcate creativity and innovation. Apart from conventional lab, the curriculum provides a freedom for students to perform industry assignments, pilot projects, innovative development, etc.
5. **Inculcating Ethics and Values:**
   To improvise student's behavior, the curriculum has included systematic courses on ethics and values. The moral principles can help students to make right decisions, lead their professional lives and become ethical citizen.
6. **Blend of Curricular and Extracurricular Activities**
   The curriculum also gives importance of different activities like co-curricular, extra-curricular, sports, culture, etc. This will help to do all round development of students in all possible ways.
7. **Four Tracks in B-Tech:**
   By offering various courses/electives, flexibility in choosing work in specified field as:
   I. Industry Internship II. Entrepreneur

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T. Y. B. Tech (Automation and Robotics)

Academic Year – 2023-2024 Semester - V

Course Code	Course	Teaching Scheme			Semester Examination Scheme of Marks						Credits
					Theory			TW	LAB	TOTAL	TOTAL
		TH	TU	LAB	ISE (15)	MSE (25)	ESE (60)				
AR3101	Computer Integrated Manufacturing Systems	3	0	0	15	25	60	-	-	100	3
AR3102	Design of Machine Elements and Transmission System	3	1	2	15	25	60	25	25	150	5
AR3103	Microcontrollers and Microprocessors	3	-	2	15	25	60	-	25	125	4
AR3104	PLC and SCADA	3	1	2	15	25	60	25	25	150	5
AR3105	Elective I	3	0	0	15	25	60	0	0	100	3
AR3106	Engineering Design & Innovations - II	0	0	2	-	-	-	-	50	50	1
AR3107	Interpersonal Skills (Soft Skills)	0	0	2	-	-	-	-	25	25	1
AR3108	Audit Course - III	No Credits									
Total of Semester		**15**	**02**	**10**	**75**	**125**	**300**	**50**	**150**	**700**	**22**

Audit Course - III

Audit Course Code	Audit Course-III
HS3106	Essence of Indian Knowledge Tradition -I
HS3108	Cultural Studies
CE 3113	Urbanization and Environment

Elective - I

Course Code	Course	Course Code	Course	Course Code	Course
AR3105A	Specialized Robotics Applications: Agriculture, Food Processing, Medical Applications	AR3105B	Totally Integrated Automation	AR3105C	Robotic Welding Technology

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T. Y. B. Tech (Automation and Robotics)

Academic Year – 2023-2024 Semester – VI

Course Code	Course	Teaching Scheme			Semester Examination Scheme of Marks						Credits
					Theory			TW	LAB	TOTAL	TOTAL
		TH	TU	LAB	ISE (15)	MSE (25)	ESE (60)				
AR3109	Automation Systems & Applications	3	0	2	15	25	60	-	25	125	4
AR3110	Robotics Kinematics and Dynamics	3	0	2	15	25	60	-	25	125	4
AR3111	Machine Vision System	3	0	2	15	25	60	-	25	125	4
AR3112	Automation System Design	3	1	0	15	25	60	25	-	125	4
AR3113	Elective - II	3	0	0	15	25	60	-	-	100	3
AR3114	Programming with Python	0	0	2	-	-	-	-	100	100	1
AR3115	Audit Course- IV	No Credits									
Total of Semester-VI		**15**	**01**	**08**	**75**	**125**	**300**	**25**	**175**	**700**	**20**

Audit Course – IV

Audit Course Code	Audit Course - IV
HS3107	Essence of Indian Knowledge Tradition -II
HS3109	Introduction to Human Factors and Ergonomics
HS3110	Mind Education

Elective - II

Course Code	Course	Course Code	Course	Course Code	Course
AR3113A	Wireless Sensors Networks for Robotics	AR3113B	Industrial Internet of Things and Its Applications	AR3113C	Additive Manufacturing

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SEMESTER V Syllabus

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3101]: Computer Integrated Manufacturing

Teaching Scheme:	Credit	Examination Scheme:
TH: 03Hours/Week	TH:03	In Sem. Evaluation:15 Marks Mid Sem. Exam: 25 Marks End Sem. Exam : 60 Marks

Course Prerequisites: The student should have completed four semesters of UG Engineering

Course Objective:

- Understand and realize need of CIM and factory automation.
- Learn to integrate hardware and software elements for CIM.
- Learn to integrate processes planning, quality and MRP with computers.
- Know about flexible, cellular manufacturing and group technology.
- Understand IOT, Industry-4.0 and cloud base manufacturing.

Course Outcome:

After successful completion of the course, students will able to:
CO1: EXPLAIN CIM and factory automation.
CO2: UNDERSTAND the integration of hardware and software elements for CIM
CO3: ANALYZE processes planning, quality and MRP integrated with computers.
CO4: INTERPRET flexible, cellular manufacturing and group technology.
CO5: ANALYZE the effect of IOT, Industry-4.0 and cloud base manufacturing**.**

Course Contents

UNIT-I	Introduction to CIM	07 Hours

Need of CIM, Introduction, Evolution of CIM,CIM Hardware and software, Role of CIM System, Definition of CIM, automation and types of automation, Reasons for automation, Types of Production, Functions in Manufacturing, CIM wheel, Computerized element of CIM, Advantages of CIM

UNIT-II	Data Integration	08 Hours

CAD-CAM Integration, Product development through CIM, Design Activities in a networked environment, Networking in a manufacturing company, hardware elements of networking, CIM Database, Database requirements of CIM, Database management, Database Models, EDM, Product Data Management (PDM), Product life cycle Management(PLM)

UNIT-III	Computer Aided Process Planning and Quality Control	08 Hours

Process Planning: Computer Aided Process Planning (CAPP), Benefits of CAPP, Logical steps in Computer Aided Process Planning, Approaches to CAPP, Material Requirement Planning, Capacity Planning, Manufacturing Resource Planning (MRP) - Input, working, outputs and benefits, Concept of dependent demand, structure of MRP system, planning & implementation issues, MRP-II & Enterprise Resource Planning (ERP), Computer Aided Production Scheduling, Control Systems: Shop Floor Control, Inventory Control, Computer Aided Inspection and Quality Control, Manufacturing Execution System(MES)

UNIT-IV	Cellular Manufacturing	08 Hours

Group Technology(GT), Part Families – Parts Classification and coding, Simple Problems in Opitz Part

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Coding system – Production flow Analysis, Cellular Manufacturing – Composite part concept – Machine cell design and layout, Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method, Arranging Machines in a GT cell – Hollier Method – Simple Problems

UNIT-V	Flexible Manufacturing Systems	08 Hours

Introduction Flexible Manufacturing Systems, FMS components, Material handling and storage system, applications, benefits, computer control systems, types of FMS Layout, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture.

UNIT-VI	Future Smart Factories	08 Hours

Industry 4.0: Functions, Applications and Benefits. Components of Industry 4.0, Introduction to Industry 5.0, Internet of Things (IoT): IoT applications in manufacturing, Big-Data and Cloud Computing for IoT, IoT for smart manufacturing, influence of IoT on predictive maintenance, Supply-Chain Optimization, Supply-Chain & logistics, Internet of Things and M2M Communication Technologies Digital Manufacturing w.r.t. Industry 4.0: Industrial Automation, Cyber-Physical Manufacturing Systems, Digital Twin Driven Smart Manufacturing, Digital Manufacturing, Assembly and Automation Systems, Scheduling and Cloud Manufacturing, Knowledge Management, Digital Supply Chains, Reconfigurable Manufacturing Systems, Web based Application in Manufacturing

Text Books:

T1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover Person India, 2007 2nd edition.

T2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India.

Reference Books:

R1. Chang, T.C. and Wysk, R.A., 1997. Computer-aided manufacturing. Prentice Hall PTR.

R2. Xu, X., 2009. Integrating Advanced Computer-Aided Design, Manufacturing, and Numerical Control. Information Science Reference.

R3. Weatherall, A., 2013. Computer integrated manufacturing: from fundamentals to implementation. Butterworth-Heinemann.

R4. Nanua Singh, Systems Approach to Computer Integrated Design and Manufacturing, John Wiley Publications.

R5. Harrington J, Computer Integrated Manufacturing Krieger Publications 1979.

R6. Zeid, CAD/CAM, Tata McGraw Hill

R7. Jha, N.K. "Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.

On-Line resources:

1. https://youtube.com/playlist?list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS
2. https://nptel.ac.in/courses/112104289
3. https://onlinecourses.nptel.ac.in/noc22_me10/preview
4. https://archive.nptel.ac.in/courses/112/104/112104289/
5. https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-me44/

Link for Virtual Lab:

1. http://vlabs.iitkgp.ac.in/cim/#

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3102] - Design of Machine Elements and Transmission System

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH:03	In Sem. Evaluation:15 Marks
TU:01 Hours/Week	TU:01	Mid Sem. Exam: 25 Marks
LAB:02 Hours/Week	LAB:01	End Sem. Exam : 60 Marks
		LAB Evaluation : 25 Marks
		Term Work : 25 Marks

Course Prerequisites: Engineering Mechanics, Strength of Materials, Theory of Machines

Course Objective:

- To introduce students to the design and theory of common machine elements and to give students.
- To impart knowledge about the different types of elements used in the machine design process, for e.g., fasteners, shafts, couplings etc. and will be able to design these elements for each application.
- To understand and apply principles of gear design to spur gears and industrial spur gear boxes.
- To learn the design machine tool gearbox.
- To learn the design material handling systems and inculcate an ability to design belt drives and selection of belt and chain drives.
- To design fasteners and welded joints subjected to different loading conditions.

Course Outcome:

After successful completion of the course, students will able to:

CO1: Formulate and analyze stresses and strains in machine elements subjected to various loads.
CO2: Analyze and design the components for power transmission like shaft and couplings.
CO3: To analyze and design different types of gears.
CO4: Develop optimum design principles and apply it to mechanical components.
CO5: Design material handling systems for the specifications stated/formulated.
CO6: Design fasteners and welded joints subjected to different loading conditions.

Course Contents

UNIT-I	Introduction to Design	08 Hours

Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Consideration - Standards and Codes - Selection of Materials –Design against Static and Dynamic Load –Modes of Failure, Factor of Safety, Principal Stresses, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

UNIT-II	Keys, Couplings and Bearings	08 Hours

Shafts -Types and application - Forces on shafts due to gears and belts, estimation of shaft size based on strength–Keys, types and applications, Design of keys - Couplings, types and applications, design of rigid couplings.

UNIT-III	Spur Gear, Helical Gear and Bevel Gear Design	08 Hours

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Introduction to gears: Gear Selection, material selection, Basic modes of tooth failure, Gear Lubrication Methods. Spur Gears: Number of teeth and face width, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength (Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation. Types of helical and Bevel gears, Terminology, Virtual number of teeth, and force analysis of Helical and Straight Bevel Gear.

UNIT-IV	Design of Machine Tool Gearbox	08 Hours

Introduction to machine tool gearboxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, gearing diagram, deviation diagram. (Note: Full design problem to be restricted up to 2 Stages only

UNIT-V	Design of Belt Drive, Chain Drive for Material Handling System	08 Hours

System concept, basic principles, objectives of material handling system, unit load and containerization. Belt conveyors, Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys.

UNIT-VI	Design of Welded, Riveted and Bolted Joints	08 Hours

Basic types of screw fasteners, Bolts of uniform strength, I.S.O. Metric screw threads, Bolts under tension, eccentrically loaded bolted joint in shear, Eccentric load perpendicular and parallel to axis of bolt, Eccentric load on circular base, design of Turn Buckle. Welding symbols, Stresses in butt and fillet welds, Strength of butt, parallel and transverse fillet welds, axially loaded unsymmetrical welded joints, Eccentric load in plane of welds, Welded joints subjected to bending. and torsional moments.

Lab Contents

Guidelines for Assessment

Practical/Oral examination based on the practical's performed in the lab. The Performance will be assessed jointly by internal and external examiners.

- Total marks assigned are 50.
- Continuous assessment will be carried out based on attendance, lab performance, and timely submission of lab file

Final practical examination for specific practical and oral examination will be conducted

List of Laboratory Assignments/Experiments

1	Design Project 1: The design project shall consist of two imperial size sheets (Preferably drawn with 3D/2D CAD software) - one involving assembly drawing with a part list and overall dimensions and the other sheet involving drawings of individual components, manufacturing tolerances, surface finish symbols and geometric tolerances must be specified to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted. Projects shall be in the form of design of mechanical systems including pressure vessel, conveyor system, multi speed gear box, I.C engine, etc. Each Student shall complete any one of the following assignments. 1. Design of Flywheel. 2. Design for Manufacture, Assembly and safe. 3. Application of Composite Material for different mechanical components.

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	1. 4. Case study of one patent/ copyright/trademark from the product design point of view. 5. Design of Human Powered system.
2	**Design Project: 2** Design projects should be practically oriented, and industry based [Design of a two Stage Gear Box] (the two stages having different types of gear pair) or single stage worm gear box.] The design project shall consist of two full imperial A1-size sheets involving assembly drawing with a part list, and overall dimensions and drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified for important surfaces. A de sign report providing all necessary calculations for design of components and assembly should be submitted in a separate file. Design Databook shall be used wherever necessary to achieve selection of standard components. 1. Design project should be assigned to group of 4 to5 students. 2. Assembly drawing for project should be drawn manually. Detailed parts of project should be drawn manually.
3	Assignments The assignment shall be internally presented in the form of power point presentation, by a group of three to five students. A report of assignment (Max 8 to 10 pages) along with print out of ppt is to be submitted. Each student shall complete any two of the following assignments, with assignment. (a) compulsory. a. Use of dimensional tolerances, Geometrical tolerances, and surface finish symbols in machine component drawings. A. Selection of materials using weighted point method. B. Selection of manufacturing methods for machine elements designed in any one of the above design projects. C. Theories of failures and their applications.

Text Books:

T1. Joseph Edward Shigley, Charles R. Mischke "Mechanical Engineering Design", McGraw Hill, International Edition, 1992

T2. Sharma. C.S. and Kamlesh Purohit, "Design of Machine Elements", Prentice Hall of India Private Limited, 2003

T3. Bhandari V.B. ―Design of Machine Elements‖, Tata McGraw Hill Pub. Co. Ltd.

T4. Juvinal R.C., Fundamentals of Machine Components Design, John Wiley and Sons

Reference Books:

R1. P. H. Black and O. Eugene Adams, Machine Design, McGraw Hill Book Co.Inc.

R2. Willium C. Orthwein, Machine Components Design, West Publishing Co. And Jaico Publications House.

R3. A.S Hall, Holowenko A.R. and Laughlin H. G, Theory and Problems of Machine Design, Schaum's Outline Series.

R4. C.S. Sharma and Kamlesh Purohit, Design of Machine Elements, PHI Learning Pvt. Ltd.

R5. D.K. Agrawal & P.C. Sharma, Machine Design, S.K Kataria and Sons

R6. P. C. Gope, Machine Design: Fundamentals and Applications, PHI Learning Pvt. Ltd.

R7. Design Data -P.S.G. College of Technology, Coimbatore

R8. V. B. Bhandari, Machine Design data book, Tata McGraw Hill Publication Co. Ltd

R9. K Mahadevan, K. Balveera Reddy, Design Data Handbook for Mechanical Engineers, CBS Publishers

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On-Line resources:

1. https://nptel.ac.in/courses/112105125
2. https://archive.nptel.ac.in/courses/112/106/112106137/

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3103]- Microcontrollers and Embedded sytems

Teaching Scheme: **TH:03 Hours/Week** **LAB:01 Hours/Week**	**Credit** **TH:03** **LAB:01**	**Examination Scheme:** **In Sem. Evaluation:15 Marks** **Mid Sem. Exam: 25 Marks** **End Sem. Exam : 60 Marks** **Lab Evaluation: 25 Marks**

Course Prerequisites: Digital Logic Design, Electronic Components and Hardware, Basics of C Language

Course Objectives:

- To identify the differences between microcontrollers and microprocessors, learn PIC microcontroller architecture.
- To understand assembly language programming and I/O port programming
- To understand PIC and AVR programming in C
- To understand system structures and real-time embedded system
- Introduce students with Target Architectures: ARM Cortex M3 processors & its Programming.
- Introduce with Real-Time Kernels and Operating Systems.

Course Outcomes:

After successful completion of the course, students will able to:

CO1: Differentiate between microprocessor and microcontroller and describe PIC microcontroller architecture.
CO2: Implement assembly language programming and I/O port programming
CO3: Implement PIC and AVR programming in C
CO4: Recognize the basic concepts of embedded systems
CO5: Analyze the role of embedded systems in industry
CO6: Analyze various features of RTOS functions in embedded systems applications

Course Contents

UNIT-I	**Introduction to Microcontroller and PIC Microcontroller Architecture**	**08 Hours**

Introduction To Microprocessor and Microcontroller: History and Evolution, types of microprocessors, Difference between Microprocessors and Microcontrollers. CPU architectures: RISC/CISC and Harvard/Von-Neumann, Overview of PIC Microcontroller family, Introduction to different microcontroller families (8051, ATMEL/AVR, and ARM).
Architecture and pin functions, Registers and Instructions, Data formats and directives

UNIT-II	**Assembly Language Programming and I/O Port Programming**	**09 Hours**

Introduction to assembly language programming, Program counter and program ROM space. Branch, Call and Time delay loop: Branch instructions and looping, Call instruction and stack, Time delay instructions and pipeline. Timing diagrams.

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I/O port programming, I/O bit manipulation programming, Arithmetic, logic instructions and programs: Arithmetic instructions, Signed number concepts and arithmetic operations, logic and compare instructions, rotate instructions and data serialization, BCD and ASCII conversion.		
UNIT-III	**PIC and AVR programming in C**	**06 Hours**
Data types and time delays in C, I/O programming, logic operations, data serialization, program ROM allocation, Program ROM allocation inC18, State diagrams, Timing diagrams in-depth.		
UNIT-IV	**Introduction to System Structures and Real-time Embedded System**	**07 Hours**
System Structures types, Real-time systems & basics, Classification, Example case studies, namely, Process control system, Avionics system, Multimedia systems, Intensive Care Computing, Modern car, Digital Flight control system, Embedded system purpose, Quality attributes, Challenges and characteristics of Embedded Computing System Design, Embedded System Design Process, Core and Supporting components of the embedded system, Embedded firmware, discussion on real-time case studies and block diagram representation of systems, Embedded design cycle-case study- Engine Control Unit , GPS Moving Map, Automatic Chocolate Vending Machine (ACVM) using Finite State machine(FSM), Unified Modeling Language(UML), state charts etc.		
UNIT-V	**Target Architectures : ARM Cortex M3 processors & its Programming**	**08 Hours**
Introduction to embedded computing with examples and arm processors, The architecture of ARM Cortex M3, Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming. Advanced Programming Features. Memory Protection. Debug Architecture. Digital Signal Processor (DSP), Field Programmable Generic Array (FPGA).Examples to demonstrate each of its architectural and programmable features. A case study on the Antilock Brake System(ABS) and stability control system		
UNIT-VI	**Real-Time Kernels and Operating Systems**	**08 Hours**
Introduction to Real-Time Kernels, Tasks, process and threads, Introduction to RTOS, key characteristics of RTOS, its kernel, components in RTOS kernel, objects, scheduler, services, context switch, Task scheduling, Task communication and synchronization, Multiprocessing and multitasking, Multi-Threading, Hyper-threading, State diagrams, timing diagrams, examples for each, Scheduling types: Preemptive priority-based scheduling, Round-robin and preemptive scheduling. First come first served scheduling, shortest job first scheduling, Device drivers and selection of an RTOS. Examples for each of the scheduling technique, objects, context switching, synchronization, and device drivers, Case study on Mars Pathfinder mission		

Lab Contents

The instructor's manual is to be developed as a hands-on resource and reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), Autonomous syllabus, conduction & Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Assessment

Practical/Oral examination based on the practical's performed in the lab. The Performance will be assessed jointly by internal and external examiners.

- Total marks assigned are 25.
- Continuous assessment will be carried out based on attendance, lab performance, and timely submission of lab file.
- Final practical examination for specific practical and oral examination will be conducted

List of Laboratory Assignments/Experiments (minimum 07 to be covered)

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Part-A: Minimum Four experiments should be conducted	
1	Write a program to demonstrate the blinking of LED in PIC16F877A and Arduino board.
2	Write a program to demonstrate a counting machine which count from 0000 to 9999 and display on 7 segment LED display using PIC16F877A and Arduino board.
3	Write a program to read the values from the temperature sensor (LM35) and display the temperature in degree Celsius on LCD display using PIC16F877A and Arduino board
4	Write a program to measure the distance of an object using ultrasonic Sensors and display the distance in terms of centimeters and inches. Make the connections as per the schematic and develop the flowchart and the code to perform the required operation
5	In bank lockers there is requiremen of password protection to open the locker. Develop an application Using a 4*3 keypad and LCD to secure the lockers by providing password protection.
6	Write a program to control the speed and direction of DC, stepper and servo motors.
7	Design a development board using Atmega328 or PIC 18 using eagle/ Dip-trace
Part-B: Minimum three experiments should be conducted.	
1	Demo on Energia IDE and TM4C1294NCPDT, TIVA C series microcontroller board & Solving problems on Data Acquisition for Bio Medical / Process control/Industrial control application
2	Demo on Code Composer Studio(CCS) and TIVA C series TM4C1294NCPDT microcontroller board and problem solving on ADC,TIMERS,INTERRUPTS
3	Demo on Code Composer Studio(CCS) and TIVA C series TM4C1294NCPDT microcontroller board and problem solving on ADC,TIMERS,INTERRUPTS
4	Demo on Raspberry Pi Programming and peripheral programming
5	Exercises on basic RTOS program , RTX Kernel using peripherals like RTC, TIMERS , UART, SEMAPHORES
6	Structured Query : Implementing Communication Protocols like I2C / SPI / UART /CAN / ETHERNET with Energia /CCS & TM4C1294 TIVA board

Text Books:

T1. Mazidi & Mazidi, " PIC Microcontroller and Embedded systems", Pearson Edition
T2. Mazidi & Mazidi, " Introduction to AVR Microcontroller and Embedded systems", Pearson Edition
T3. James K. Peckol, " Embedded Systems A Contemporary Design Tool," Wiley student edition
T4. .Joseph Yiu " The Definitive Guide to the ARM Cortex–M3"
T5. .Silberschatz, Galvin, and Gagne, "Operating system concepts," 8th edition, WILEY

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REFERENCEBOOKS:

R1. Ramesh Gaonkar, Fundamentals of microcontrollers and Applications in Embedded Systems. Penram International Publishing (India) Pvt. Ltd.
R2. Kenneth J. Ayala, 'The 8051 Microcontroller Architecture, Programming and Applications', Cengage Learning, 3 rd Edition.
R3. M Krishnakumar, "Microprocessors and Microcontrollers".
R4. Ajay Deshmukh, "Microcontrollers Theory and Applications", TATA McGraw Hill, 4th Edition
R5. Peatman, John B, "Design with PIC Microcontroller", Pearson Education PTE, 1 st Edition
R6. Data Sheet of PIC 18Fxxxx series
R6. William Hohl, "ARM Assembly Language Fundamental and Techniques", CRC Press Taylor & Francis, 2009.
R7. Steve Furber, "ARM Systems on-Chip Architecture", Pearson Education, 2009.
R8.Shibu K V, "Introduction to Embedded Systems Tata McGraw Hill, New Delhi, 6th reprint 2012.
R9. Raj Kamal," Embedded Systems," McGraw-Hill Education
R10. Steve Furber, "ARM System-on-Chip Architecture" LPE, Second Edition.

On-Line Resources:

https://nptel.ac.in/courses/117/104/117104072/
https://nptel.ac.in/courses/108/105/108105102/

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3104] - PLC and SCADA

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH:03	In Sem. Evaluation:15 Marks
TU:01 Hours/Week	TU:01	Mid Sem. Exam: 25 Marks
LAB:02 Hours/Week	LAB:01	End Sem. Exam : 60 Marks
		LAB Evaluation : 25 Marks
		Term Work : 25 Marks

Course Prerequisites: Basics of sensing elements, bridges and basic electronics Course

Course Objective:

1. To understand PLC basics
2. To understand types of PLC inputs and outputs
3. To apply the knowledge of PLC programming instructions
4. To understand SCADA importance in Industry
5. To understand Networking in Industrial Automation
6. To apply the practical applications of PLC programming in Industries

Course Outcome:

After successful completion of the course, students will able to:

CO1: Explain the basics of PLC
CO2: Classify and Explain PLC inputs and outputs
CO3: Implement advanced PLC programming for Industrial usage
CO4: Explain the basics of SCADA
CO5: Demonstrate the Industrial Networking in SCADA
CO6: Apply the knowledge of PLC in Industries

Course Contents

UNIT-I	INTRODUCTION	07 Hours

Introduction, - Need for PLC, PLC evolution, PLC input/output instructions, Development of Relay ladder logic, PLC Configuration, Scan cycle, Capabilities of PLC, Selection criteria for PLC

UNIT-II	Programmable Logic Controller	07 Hours

Types of Programming Languages ,Ladder programming for logic gates & Boolean algebra, PLC Wiring-Sourcing and Sinking concepts, PLC input/output instructions

UNIT-III	PLC Programming	07 Hours

Types of Programming – Bit Instructions -Timers and counters– PLC arithmetic functions PTO / PWM generation- High Speed Counter – Analog Scaling – Encoder Interfacing- Servo drive control – Stepper Motor Control

UNIT-IV	Supervisory Control and Data Acquisition	07 Hours

Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, important definitions HMI, MTU, RTU, communication means, Desirable Properties of SCADA system, advantages, disadvantages and applications of SCADA. SCADA

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generations (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture Functions and features of SCADA systems, System operating states, SCADA system in critical infrastructure: Petroleum Refining Process, Conventional electric power generation, Water Purification System, Chemical Plant.

UNIT-V	Networking in SCADA	07 Hours

PLC Networking- Networking standards & IEEE Standard - Protocols - Field bus - Process bus, Modbus and Ethernet -CAN Open. Case studies of manufacturing automation and Process automation**.**

UNIT-VI	Applications of PLC and SCADA	07 Hours

Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control, Automatic car washing machine, Bottle label detection and process control application, Design a SCADA system for Manufacturing plant

Lab Contents

Guidelines for Assessment

Practical/Oral examination based on the practical's performed in the lab. The Performance will be assessed jointly by internal and external examiners.

- Total marks assigned are 25.
- Continuous assessment will be carried out based on attendance, lab performance, and timely submission of lab file

Final practical examination for specific practical and oral examination will be conducted

List of Laboratory Assignments/Experiments

1	PLC Programming on basic logic gates
2	Develop a PLC Program to Detect the standing bottles on the conveyor and pushing falling bottles in tray.
3	Develop a PLC programming for Automation System
4	Implement controlling of Traffic Lights in PLC using Ladder Diagram programming language.
5	Develop PLC Program to Change Preset Value of Counter According to Various Products. A parking plot has total capacity of Cars. Number of empty spots is displayed on the display outside the Parking Plot and which spots are available is to be indicated by LEDs.
6	Implement this in PLC using Ladder Diagram programming language.
7	Develop Logic gates using SCADA software
8	Implement controlling of Traffic Lights using SCADA software
9	Develop Analog and Digital Alarm Lights using SCADA software
10	Develop Historical and Real Time Trends using SCADA software

Text Books:

T5. Programmable Logic Controllers: Principles & Applications by John W. Webb, Ronald A. Reis, Prentice Hall of India, 5th ed.

T6. Introduction to Programmable Logic Controllers by Gary Dunning, Delmar Thomson Learning, 3rd ed

T7. Programmable Logic Controllers: Programming methods and applications by John R. Hackworth and Frederick D. Hackworth Jr. Pearson publication

Reference Books:

R10. Programmable Logic Controller by Frank D Petruzella, McGraw-Hill Education, 5th ed.

R11. Programmable Logic Controllers by W. Bolton, Elsevier Newness publication, 4th ed

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R12. SCADA by Stuart A. Boyer, ISA 1999.

On-Line resources:

3. https://learn.realpars.com/courses/codesys-1-introduction-to-plc-programming
4. https://onlinecourses.nptel.ac.in/noc21_me67/preview

List of Tutorials:

1. Practical study of different practical Applications
2. VFD programming

List of Projects:

1. Automation in Hydraulics and Pneumatics
2. Automation in Pick and place on conveyor

List of Course Seminar Topics:

1. Sensors and switches
2. SCADA Applications
3. VFD Programming

List of Course Group Discussion Topics:

1. Industrial Revolution 4.0
2. Application of PLC in Manufacturing

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3105A]: Elective I
Specialized Robotics Applications: Agriculture, Food Processing, Medical applications

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH:03	In Sem. Evaluation:15 Marks Mid Sem. Exam: 25 Marks End Sem. Exam : 60 Marks

Course Prerequisites: The student should have completed four semesters of UG Engineering

Course Objective:

This course attempts to address the applications of robots in some specific areas where the use of robots have significantly improved productivity

Course Outcome:

After successful completion of the course, students will able to:

CO1: Understand the various types of Industrial, field and service Robots and their characteristics and capabilities.
CO2: Equip with the knowledge of Mathematical modeling of specialized Robots
CO3: Familiarize with the operation of Robots and processes involved
CO4: Select the right Robot with required configurations and specifications for applications.
CO5: Familiarize with the applications of various fields and service Robots.

Course Contents

UNIT-I	Applications of Robots In Industries	08 Hours

Introduction to robotics - overview, A short history of industrial Robots - Applications of Robots in Welding, Car body assembly, painting- Applications of Robot in Machining, material transfer- Kinematics and mechanisms review, tasks descriptions, teaching and programming- End-effectors and system integration.

UNIT-II	Cooperative and Swarm Robots	07 Hours

Cooperative manipulation, Challenges in cooperative manipulation- Case studies for Cooperative manipulation for Industrial and Service applications- Introduction to swarm Robots, comparison with other multi-agent systems, challenges and benefits of swarm systems- Algorithms for swarm Robots, application, case study of swarm Robots.

UNIT-III	Field Robotics	07 Hours

Forestry, Robot locomotion, forestry automation, SLAM in forestry- autonomous Robots for silviculture and treatment- Broad acre Applications: Automatic guidance, sowing, weeding, spraying and broad-acre harvesting, Horticulture: picking of fruits- Robot milking, sheep shearing, slaughtering, livestock inspection- Robots in construction, unsolved problems in construction, Future directions- Robots for hazardous applications, enabling technologies- Search and Rescue robotics: Disaster characteristics-Impact on Robots, Robots actually used at disaster, promising robots, open issues – case studies.

UNIT-IV	Robots In Surgery and Rehabilitation	07 Hours

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Medical robotics, Core concepts, Technology- Medical robotic systems, Research areas and applications- Rehabilitation and Health care robotics: Overview, physical therapy and training Robots- Aids for people with disabilities- Smart prostheses and orthoses, diagnosis and monitoring.		
UNIT-V	**Entertainment and Personal Robotics**	**07 Hours**
Cleaning Robots, lawn moving Robots- Smart appliances and smart homes- The role of Robots in education, Educational robotic platforms-. Robots and informal learning venues		
UNIT-VI	**Underwater Robotics**	**07 Hours**
Introduction : Robotics in Water - Basics Representation of Underwater Robot - Types and Classification of Underwater Robotics - Differentiating Aerial and Underwater Robotics - why it is called an perfect engineering product - Overview about Environmental Factors affecting object in water. Control System and Manipulator : Control System and Types of Control Systems in Underwater Robotics - Sensors Connected with the Underwater Robotics - Introduction to Underwater Manipulators - Introduction to Hydraulics on Underwater Vehicles - Applications of Underwater Vehicles.		

Text Books:

T1. Bruno Siciliano, Oussama Khatib, ―Springer Handbook of Robotics‖, Springer-Verlag Berlin Heidelberg 2008.

T2. Yangsheng Xu Huihuan Qian Xinyu Wu, "Household and Service Robots", Elsevier Ltd, 2015.

Reference Books:

R1. Aleksandar Lazinica, ―Mobile Robots Towards New Applications‖, Advanced Robotic Systems International, 2006.

R2. Gregory Dudek,Michael Jenkin, ―Computational Principles of Mobile Robotics‖, 2nd edition, Oxford University Press, 2010.

R3. L Marques,A de Almeida,Mo Tokhi,GSVirk, ―Advances in Mobile Robotics‖, World Scientific Publishing Co. Pte. Ltd. 2008.

R4. Gianluca Antonelli , "Underwater Robots", Springer, 2014

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3105B]: Elective I
Total Integrated Manufacturing

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH: 03	In Sem. Evaluation:15 Marks Mid Sem. Exam: 25 Marks End Sem. Exam : 60 Marks

Course Pre requisites:

Course Objective:

- To gain knowledge in automation in industries.
- To gain knowledge in various electrical and electronic programmable automations and their applications.
- To know about the basic in SCADA and DCS systems.
- To gain knowledge in communication protocols in an integrated system
- To know about the advanced in automation industries

Course Outcome:
After successful completion of the course, students will able to:
CO1: Knowledge of PLC& PAC automation.
CO2: Ability to apply SCADA and usage of C programming for report generation.
CO3: Acquiring information's on communication protocols in automation systems
CO4: Ability to design and develop automatic control system using distributed control systems
CO5: Knowledge in automation of industries.

Course Contents

UNIT-I	TOTALLY INTEGRATED AUTOMATION	09 Hours

Need for TIA - TIA Architecture - Components of TIA systems - Selection of TIA Components – Programmable Automation Controllers (PAC) - Vertical Integration structure.

UNIT-II	SUPERVISORY CONTROL AND DATA ACQUISITION	09 Hours

Overview – Developer and runtime packages – Architecture – Tools – Tags – Graphics - Alarm logging – Tag logging – Trends – History – Report generation, VB & C Scripts for SCADA application.

UNIT-III	COMMUNICATION PROTOCOLS OF SCADA	09 Hours

Proprietary and open Protocols – OLE/OPC – DDE – Server/Client Configuration – Messaging – Recipe – User administration – Interfacing of SCADA with PLC, drive, and other field device

UNIT-IV	DISTRIBUTED CONTROL SYSTEMS (DCS):	09 Hours

DCS – architecture – local control unit- programming language – communication facilities – operator interface – engineering interfaces.

UNIT-V	INDUSTRIAL PLANT DESIGN	09 Hours

Design criteria – Process sequencing - Plant layout modeling – Selection of industrial power and automation cables, Overview of plant simulation software. Case Studies: Case studies of Machine automation, Process automation.

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UNIT-VI	HMI SYSTEMS	09 Hours
Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI- Text display - operator panels - Touch panels - Panel PCs - Integrated displays (PLC & HMI). Check with PLC 502 and remove		
Text Book: T1.John.W.Webb & Ronald A. Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2003. T2. Michael P. Lukas, "Distributed Control systems", "Van Nostrand Reinfold Company"1995 T3. David Bailey, Edwin Wright, ―Practical SCADA for industry, Newnes, Burlington, 2003. T4. Gordon Clarke, Deon Reynders,Edwin Wright, ―Practical Modern SCADA Protocols: DNP3, 60870.5and Related systems‖, Newnes Publishing, 2004.		
Reference Books: R1. Win C C Software Manual, Siemens, 2003 R2. RS VIEW 32 Software Manual, Allen Bradly, 2005 R3. CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004		
On-Line resources:		

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3105C]: Elective I
Robotic Welding Technology

Teaching Scheme:	Credit	Examination Scheme:
TH: 03Hours/Week	TH:03	In Sem. Evaluation:15 Marks Mid Sem. Exam: 25 Marks End Sem. Exam : 60 Marks

Course Prerequisites: Engineering Physics, Engineering Chemistry, Manufacturing processes, Material Science and Metallurgy, Engineering Physics, Systems in Mechanical Engineering

Course Objective:

In this course Students will be introduced to robotic welding systems as well as learn how to perform basic procedures on a system. The student will learn how to create welding routines, program their own weld paths, and be able to store and retrieve programs and parameters. Students will learn to program a welding robot through a teach pendant and through simulation software, edit programs, set weld schedules, as well as learn basic operator controls and indicators on the teach pendant and operator panel. This course also provides fundamental safety precautions while programming and operating the robotic equipment. There are also following objectives for this course-

1. To give an understanding of welding metallurgy and weld ability and to introduce various Metal joining techniques.
2. To understand the principles, equipment's of different welding and joining techniques.
3. To know about Unconventional machining processes.
4. To Classify, describe and configure the principles of various welding techniques

Course Outcome:

After successful completion of the course, students will able to:

CO1: Understand the basics of the primary manufacturing processes and apply the knowledge in designing parts for robotic applications

CO2: Understand the various joining processes and choose the appropriate mechanical and Adhesive joining process for the parts.

CO3: Understand the various nonconventional and net-shape manufacturing techniques and Optimally select the appropriate process to realise a part.

CO4: Use welding equipment's to join the structures.

CO5: Acquire knowledge in various types of welding processes.

CO6. Classify and Explain different welding processes and evaluate welding characteristics

Course Contents

UNIT-I	WELDING AUTOMATION	08 Hours
Concept of manual, automatic and automated welding; Need for Welding Automation – merits, limitations, arc and work motion devices, Robotic part-holding positioners, Flexible automation of arc welding, remote welding		
UNIT-II	**WELDING PROCESS FOR ROBOTIC WELDING**	**06 Hours**

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Review of welding process GTAW, GMAW – welding power sources, electrodes, shielding gases, process parameters, Hot wire, ATIG processes, synergic GMAW, CMT, Rapid Arc GMAW process		
UNIT III	**WELDING PROCESS**	**06 Hours**
Wire Arc additive manufacturing process, LBW – solid state lasers, gas lasers, process parameters, RSW – power sources, electrodes, process variables, FSW - equipment, process parameters, Thermal Assisted FSW, process variants		
UNIT-IV	**WELDING ROBOTS**	**10 Hours**
Types of welding robots – features of welding Robot – Wrist motions - Specifying the welding Robot controllers- major components, functions- Interfacing welding power source with robotic controller – welding control system		
UNIT-V	**ROBOTIC WELDING**	**10 Hours**
Robotic welding system, Programmable and flexible control facility -Introduction-Types- Flex Pendant- Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding		
UNIT-VI	**APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES**	**08 Hours**
Application of robot in production: Exploration of practical application of robots in welding: robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering - Applications in nuclear, aerospace and ship building, case studies for simple and complex applications		
Text Books: T1. Pires J N, Loureiro A, Bolmsjo G, "Welding Robots: Technology, System Issues and Application", 1st Edition, Springer, 2006. T2. Howard B, Carry , "Arc Welding Automation", Marcel Dekker, Inc, New York, 1995.		
Reference Books: R1. Parmar R S , "Welding Processes and Technology", Khanna Publishers, New Delhi, 2012. R2. Shimon Y N , "Handbook of Industrial Robotics", 2nd Edition, John Wiley & Sons, 2013. R3. John A. piotrowski, William T. Randolph , "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987. R4. Jack D Lane , "Robotic Welding", IFS Publication, 1987.		
MOOC(NPTEL) Courses: https://nptel.ac.in/courses/112107144/		

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3106]: Engineering Design & Innovations –II

Teaching Scheme:	Credit	Examination Scheme:
PR: 02 Hours/Week	PR:01	Practical Exam 50 Marks Total :50 Marks

Course Prerequisites : Engineering Design & Innovations -I

Course Objective:

- To orient the students to identify the problem precisely and subsequently do the synthesis.
- To orient the students to apply their knowledge preferably in real life engineering problem solving.
- To evolve students in conceptual, lateral, and out of box thinking.

Course Outcomes:

After successful completion of the course, students will able to:
CO1: Apply basic principles and concepts for development of working model.
CO2: Explain and present the working model.
CO3: Develop skills of technical report writing and presentation.
CO4: Write comprehensive report on mini project work.

Guidelines:

1. Engineering Design & Innovations –IIcan be an individual or a group activity (maximum 4 students) depending on the depth and scope of the topic.
2. The project work can be any of the form given below :
    a. Making physical working models, prototypes, and scaled models of a concept machine.
    b. Making virtual / CAD models of a sufficiently complex machines / concepts.
    c. Design, modelling, analysis, programming and simulation of a system / machine / operation / process.
    d. Teaching modules of a sufficiently complex topic for pedagogy purposes.
    e. Project should include mainly Mechanical Engineering contains but can be multi-disciplinary too.
3. Group formation, discussion with faculty advisor, formation of the Semester Project statement, resource requirement should be carried out in the earlier part of the Semester.
4. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini-project.
5. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
6. The students are expected to utilize the laboratory resources before or after their contact hours as per the prescribed module.
7. A complete Assembly and detailed drawings of the project should be submitted along with a detailed project report, where applicable.
8. A detailed background / field / literature survey, related to the topic must be made and presented in the report.

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9. Completed project and documentation in the form of project report is to be submitted at the end of the semester.
10. Review – I: During Mid Semester Examination as per the Academic Calendar.
11. Review – II: The last week of the Semester.

EVALUATION SCHEME :

1. Attendance during Semester – 5 marks
2. Regularity in project work execution and reporting – 5 marks
3. Relevance of Project topic – 5 marks
4. Timely Abstract submission – 5 marks
5. Literature review – 5 marks
6. Technical contents /skills / knowledge – 5 marks
7. Presentation – 10 marks
8. Question & answer session – 10 marks

Total = 50 marks

Duration of presentation – 10 minutes , Question and answer session – 5 minutes

INSTRUCTIONS FOR REPORT WRITING

It is important that the procedures listed below be carefully followed by all the students of T. Y. B. Tech (Mechanical Engineering).

1. Prepare **Three Spiral Bound Copies** of your manuscript.
2. Limit your Project report to 30-40 pages (preferably)
3. The footer must include the following:
Institute Name, T.Y. B. Tech (Mechanical) Times New Roman 10 pt. and centrally aligned.
4. Page number as second line of footer, Times New Roman 10 pt. centrally aligned.
5. Print the manuscript using
a) Letter quality computer printing.
b) The main part of manuscript should be Times New Roman 12 pt. with alignment - justified.
c) Use 1.5 line spacing.
d) Entire report shall be of 5- 7 chapters
6. Use the paper size 8.5'' × 11'' or A4 (210 × 197 mm). Please follow the margins given below.

Margin Location	Paper 8.5"*11*	Paper A4(210*197mm)
Top	1"	25.4mm
Left	1.5"	37mm
Bottom	1.25"	32mm
Right	1"	25.4mm

7. All paragraphs will be 1.5 lines spaced with a one blank line between each paragraph. Each paragraph will begin with without any indentation.
8. Section titles should be bold with 14 pt. typed in all capital letters and should be left aligned.
9. Sub-Section headings should be aligning at the left with 12 pt. bold and Title Case (the first letter of each word is to be capitalized).
10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, black and white. Illustrations downloaded from internet are not acceptable.
a) Illustrations should not be more than two per page. One could be ideal

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b) Figure No. and Title at bottom with 12 pt.
c) Table No. and Title at top with 12 pt.
d) Legends below the title in 10 pt.
e) Leave proper margin in all sides.
f) Illustrations as far as possible should not be photo copied.
11. Photographs if any should be of glossy prints.
12. Please use SI system of units only.
13. Please number the pages on the front side, centrally below the footer.
14. References should be either in order as they appear in the thesis or in alphabetical order by last name of first author.
15. Symbols and notations if any should be included in nomenclature section only.

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TATHAWADE, PUNE-33
(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3107]: Interpersonal Skills (Soft Skills)

Teaching Scheme:	Credit	Examination Scheme:
LAB:02 Hours/Week	LAB: 01	LAB Evaluation : 25 Marks

Guidelines for Assessment/Guidelines for Lab /TW Assessment

Practical/Oral examination based on the practical's performed in the lab. The Performance will be assessed jointly by internal and external examiners.

- Total marks assigned are 25.
- Continuous assessment will be carried out based on attendance, lab performance, and timely submission of lab file
- Final practical examination for specific practical and oral examination will be conducted

List of Laboratory Assignments/Experiments

1	Skill training, Employability training, Pre-job trainings.
2	Introduce yourself with SWOT analysis
3	Life Skill Management.
4	Development of leadership qualities and Public speaking skills.
5	Group discussion on environment protection.
6	Confidence Management.
7	A group discussion on importance of personality development.
8	Assignment on Goal Setting and Time Management.
9	Assignment on Team building and assigning work distribution.
10	Assignment on computer ethics (Social impact of computers)
11	Assignment **On the Job Training** (OJT) and apprenticeships shall form an integral part of a skills based program.

Reference Books:

R1. Campbell, J., Baikaloff, N., & Power, C. (2006). Towards a global community: Educating for tomorrow's world. Dordrecht: Springer

R2. Boston Consulting Group (2010), Winning in Emerging Market Cities: A Guide to the World's Largest Growth Opportunity, Boston Consulting Group, Boston

R3. M. Govindarajan, S. Natarajan, V.S. Senthil Kumar, "Professional Ethics and Human Values", PHI Learning Press

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -V
[AR3108]: AUDIT COURSE - III

Teaching Scheme: -	**Credit: -**	**Examination Scheme: -**

List of Courses to be opted (Any one) under Audit Course **III**

Code	**Name of Course**	**Link**
HS3106	Essence of Indian Knowledge Tradition -I	https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-2/ug-vol2.pdf
HS3108	Cultural Studies	https://onlinecourses.swayam2.ac.in/aic19_as04/preview
CE 3113	Urbanization and Environment	https://onlinecourses.nptel.ac.in/noc21_hs96/preview

GUIDELINES FOR CONDUCTION OF AUDIT COURS

A student shall be awarded the bachelor's degree if he/she earns 170 credits and clears all the audit courses specified in the syllabus. The student shall be awarded grade as AP (Audit Course Pass) on successful completion of audit course. The student may opt for one of the audit courses per semester, starting from second year first semester. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course shall be done. Method of conduction and method of assessment for audit courses are suggested.

Using NPTEL Platform:

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Student can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course.
- Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal.
- After clearing the examination successfully; student will be awarded with certificate.

Guidelines for Assessment:

The assessment of the course will be done at the institute level. The department has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary.

- During the course students will be submitting the online assignments. A copy of same students can submit as a part of term work for the corresponding Audit course.
- On the satisfactory submission of assignments, the institute can mark as "Present" and the student will be awarded the grade AP on the marksheet.

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SEMESTER VI Syllabus

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -VI
[AR3109]- Automation Systems and Applications

Teaching Scheme:	Credit	Examination Scheme:
TH: 03Hours/Week LAB: 02Hours/Week	TH: 03 LAB:01	In Sem. Evaluation:15 Marks Mid Sem. Exam: 25 Marks End Sem. Exam: 60 Marks Lab Evaluation: 25 Marks

Course Pre requisites: Basic Knowledge of Mechatronics System and Automation system

Course Objective:

- To know about the basic concepts in Manufacturing Systems
- To know about transfer lines and automated assembly
- To understand design of automated system
- To understand condition monitoring of manufacturing systems
- To design high speed automatic assembly.
- To understand the modeling of automated manufacturing systems

Course Outcome:

After successful completion of the course, students will able to:

CO1: Knowledge of Manufacturing Systems
CO2: Knowledge of industrial automation by transfer lines and automated assembly lines.
CO3: Ability to design an automated system
CO4: Knowledge of condition monitoring of manufacturing systems
CO5: Knowledge of design high speed automatic assembly
CO6: Knowledge of the modeling of automated manufacturing systems

Course Contents

UNIT-I	Manufacturing Systems	07 Hours

Components of Manufacturing systems, Classification of Manufacturing Systems, overview of Classification Scheme, Single Station Manned Workstations and Single Station Automated Cells. Assembly process and systems assembly line, line balancing methods.

UNIT-II	Transfer Lines and Automated Assembly	07 Hours

General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, modular fixturing. Flow line balancing.

UNIT-III	Design of Mechatronic Systems	07 Hours

Stages in design, traditional and mechatronic design, possible design solutions. Case studies-pick and place robot, engine management system.

UNIT-IV	Programmable Automation	07 Hours

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Special design features of CNC systems and features for lathes and machining centers. Drive system for CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems.		
UNIT-V	**Design for High Speed Automatic Assembly**	**07 Hours**
Introduction, Design of parts for high speed feeding and orienting, high speed automatic insertion. Analysis of an assembly. General rules for product design for automation.		
UNIT-VI	**Modeling Automated Manufacturing Systems**	**07 Hours**
Modeling Automated Manufacturing Systems: Role of Performance Modeling, Performance Measures, Performance Modeling Tools: Simulation Models, Analytical Models.		

Text Books:

T1. Mikell P Grover, "Automation Production Systems and Computer Integrated Manufacturing", Pearson education, New Delhi, 2001.

T2. Bolton W, "Mechatronics", Pearson Education, 1999.

Reference Books:

R1. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications" , McGraw Hill , New York, USA. 2000.

R2. Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001.

R3. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press, 2011

Lab Contents

Guidelines for Assessment

Practical/Oral examination based on the practical's performed in the lab. The Performance will be assessed jointly by internal and external examiners.

- Total marks assigned are 25.
- Continuous assessment will be carried out based on attendance, lab performance, and timely submission of lab file

Final practical examination for specific practical and oral examination will be conducted

List of Laboratory Assignments/Experiments

1.	Industrial Robot Programming for an Automation system
2.	Automation using PLC such as bottle filling, elevator control
3.	Online inspection using machine vision system
4.	Process automation simulation using SCADA
5.	Interfacing HMI with PLC
6.	Factory flow simulation
7.	Design of mechatronic system
8.	Industry Visit

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -VI
[AR3110]- Robotics Kinematics and Dynamics

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH: 03	In Sem. Evaluation:15 Marks
LAB:02 Hours/Week	LAB: 01	Mid Sem. Exam: 25 Marks
		End Sem. Exam : 60 Marks
		LAB Evaluation: 25 Marks

Course Pre requisites: Engineering Mechanics, Strength of Materials, Design of Machine Elements

Course Objective:

- To get acquainted with basic components of robotic systems. Basics of robot mechanism (Links, Actuators, end effectors etc).
- To understand statistics & kinematics of robots
- To study various gripper mechanisms and sensors and understand desired motion of robot.
- Control system necessary for accurate operation of the robot.
- To conversant with balancing problems of machines

Course Outcome:

After successful completion of the course, students will able to:
CO1: Select the type of mechanism for the robotic applications
CO2: Perform kinematic analysis, synthesis of mechanisms.
CO3: Perform forward and inverse kinematics of robots.
CO4: Apply design procedure for mechanical grippers depending upon their types and mechanism.
CO5: Design of robot manipulators based on dynamic analysis.

Course Contents

UNIT-I	ROBOT MECHANISMS	07 Hours

Kinematic Link ,Types of links, Kinematics pair, Types of constrained motion, Classification of Kinematics pairs, Kinematics chain, Degrees of freedom of mechanisms, Inversion of mechanism, Analysis of mechanisms such as Gear trains, cams and followers, belt drives, four bar mechanism, slider crank mechanism etc. Computer aided analysis and synthesis of coupler curves for four bar/five bar mechanism and slider crank mechanisms,

UNIT-II	FORWARD KINEMATICS	07 Hours

Robot kinematics-Types- 2D, 3D Transformation, D-H Representation, Displacement Matrices for Standard Configurations, Forward kinematics of manipulators up to 6 degrees of freedom

UNIT-III	INVERSE KINEMATICS	07 Hours

Inverse kinematics analysis of robot with standard configurations, methods for solution of non-linear simultaneous equations, use of meta-heuristics for inverse kinematic solutions

UNIT-IV	ROBOT END EFFECTORS	07 Hours

Types of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive grippers, tools.

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force analysis, the robot end effectors interface, considerations in gripper selection and design		
UNIT-V	**ROBOT ARM DYNAMICS**	**07 Hours**
Robot dynamics – Rigid body dynamics, Newton-Euler formation, Lagrange-Euler, formation, generalized D'Alembert equations of motion.		
UNIT-VI	**WORKSPACE ANALYSIS**	**07 Hours**
Workspace analysis of Four axis, Five axis and Six axis robots, Perspective transformation, structured illumination, Camera calibration, Work envelope of Four and Five axis robots, Workspace fixtures.		

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List of Laboratory Assignments/Experiments

1	Experiment on Robot forward kinematic analysis.
2	Experiment on Robot inverse kinematic analysis
3	Selection of gripper & sensors for any one application
4	Detail report on any one standard configuration viz. PUMA, SCARA, Stanford etc.
5	Industrial visit and its report on industrial applications of robots
6	Design ,modeling and analysis of two different types of grippers
7	Two program for linear and nonlinear path
8	Study of robotic system design
9	Setting robot for any one industrial application.
10	Study of sensor integration
11	Robot Programming for Color identification/shape identification/path tracking
12	Programming the robot for pick and place operation using any robot

Text Books:

T1. Deb S.R.,Robotics, Tata McGraw Hill Publications, New Delhi
T2. Yoram Koren, "Robotics for Engineers", McGraw Hill Book Co.
T3. Groover M.P, Weiss M, Nagel R.N, Odrey N.G, "Industrial Robotics Technology-Programming and Applications", McGraw Hill Book Co.
T4. Fu K.S, Gonzalex R.C, Lee C.S.G, "Robotics Control Sensing, Vision and intelligence", McGraw Hill Bo Co
T5. Robert J. Schilling, Fundamentals of Robotics Analysis and Control‖, PHI Learning, 2011.
T6. Niku S B, Introduction to Robotics, Analysis, Systems, Applications‖, Prentice Hall, 2001.

Reference Books:

R1. Hartenberg and Denavit, "Kinematics and Synthesis of Linkages", McGraw Hill Book Co.
R2. J. E. Shigley and J.J.Uicker Jr, Theory of Machines and Mechanism, McGraw Hill [ISBN019515598X]
R3. G K Grover', "Mechanical Vibration", Nemchand and brothers. [ISBN8185240752]
R4. S.S.Ratan , Theory of Machines, Tata McGraw Hill [ISBN0070591202]
R5. YoramKoren, "Robotics for Engineers", McGraw Hill Book Co.

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R6. Groover M.P., Weiss M., Nagel R.N., Odrey N.G., "Industrial Robotics Technology-Programming and Applications", McGraw Hill Book Co.

On-Line Resources:

1. https://www.coursera.org/specializations/modernrobotics
2. Pratihar, D. K., (2019), "Robotics,: IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc19_me74/preview
3. Asokan, T., Ravindran, B., Vasudevan, K., (2020), "Introduction to Robotics," IIT Madras, https://onlinecourses.nptel.ac.in/noc20_de11/preview
4. www.roboanalyzer.com

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -VI
[AR3111]- Machine Vision System

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH: 03	In Sem. Evaluation:15 Marks
LAB:02 Hours/Week	LAB: 01	Mid Sem. Exam: 25 Marks
		End Sem. Exam : 60 Marks
		LAB Evaluation : 25 Marks

Course Pre requisites: Digital image processing, MATLAB, Vision system, Robotic Sensor, Automated Scanning/Tracking system

Course Objective:

- To study the Basics of the vision systems and algorithms of vision systems.
- To study the recognition technique for objects
- To study the applications and software for vision systems

Course Outcome:
After successful completion of the course, students will able to:
CO1: Predict the vision systems fundamentals, Knowledge of vision systems.
CO2: Apply suitable algorithm to predict objects
CO3: Design object recognition techniques for detecting the objects
CO4: Design simple vision robot applications and Knowledge for recognizing the objects
CO5: Explain the concepts of machine vision, industrial machine vision
CO6: Knowledge in application of vision and image processing in robot operations

Course Contents

UNIT-I	**Vision System**	**06 Hours**

Basic Components - Elements of visual perception: structure of human eye, image formation in the eye – pinhole cameras - color cameras – image formation model – imaging components and illumination techniques - picture coding – basic relationship between pixels - Camera-Computer interfaces.
Basic Components – Elements of visual perception, Lenses: Pinhole cameras

UNIT-II	**Supervisory Control and Data Acquisition**	**08 Hours**

Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement: Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation – Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.

UNIT-III	**Object Recognition**	**08 Hours**

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values.

UNIT-IV	**Applications**	**07 Hours**

Transforming sensor reading, Mapping Sonar Data, aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.

UNIT-V	**Industrial Plant Design**	**07 Hours**

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Introduction, definition, Active vision system, Machine vision components, hardware's and algorithms, image function and characteristics, segmentation, data reduction, feature extraction, edge detection, image recognition and decisions, application of machine vision such as in inspection of parts, identification, industrial robot control, mobile robot application, Competing technologies, area scan sensor

UNIT-VI	**Robot Vision**	**07 Hours**

Industrial machine vision in production and services, structure of industrial M/C vision, generic standards, rules of thumb, illumination, optics, image processing, interfacing machine vision system, vision system calibration.

Lab Contents

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List of Laboratory Assignments/Experiments

1	Counting similar shaped objects from image.
2	Classifying similar objects from image.
3	Color-Based Segmentation Using K-Means Clustering.
4	Line follower robot control
5	Understandings of Robot vision – object tracking and image processing software
6	Understanding algorithms in vision system
7	Understanding different techniques of Object recognition
8	Object Detection and Reconstruction Using CNN
9	Design of Autonomous Mobile Robo
10	POSE Estimation Using Monocular and Stereo Camera

Text Book:

T1. Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim, 2008.

T2. Damian m Lyons, "Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.

T3. David.A. Forsyth, Jean Ponce, "Computer Vision a Modern Approach", Pearson, Upper Saddle River, 2010.

Reference Books:

R1. Rafael C.Gonzalez and Richard E. Woods, "Digital Image Processing", Richard E. Woods, pearson Education 2009.

R2 Milan Sonka, Vaclav Hlavac, Roger Boyle "Image Processing, Analysis and Machine Vision", Cengage learning, 2014.

R3. Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2000.

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -VI
[AR3112]- Automation System Design

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	TH: 03	In Sem. Evaluation:15 Marks
TU: 01 Hours/Week	TU:01	Mid Sem. Exam: 25 Marks
		End Sem. Exam: 60 Marks
		Term Work : 25 Marks

Course Pre requisites: Basic Knowledge of Mechatronics System and Automation system

Course Objective:

- The fundamentals of various microelectronic systems.
- The concepts related to automation components.
- Automated system development with integration of multiple systems.

Course Outcome:

After successful completion of the course, students will able to:

CO 1. Specify the automation elements and requirements
CO 2. Select the appropriate precision motion components based on the application
CO 3. Analyze the motion control with more precise arrangements
CO 4. Describe the basic design considerations of material handling equipment
CO 5. Design and select a belt conveyor for real world applications.
CO 6. Analyze the integrating automation components.

Course Contents

UNIT-I	INTRODUCTION TO PROCESS AUTOMATION	07 Hours

Process Automation – Paper industry, Packaging industry, Food Processing Industry, Integrated design issues in automation systems, The Mechatronics design process- Benefits, Modeling of Electromechanical systems, Bond graph technique, Automation migration strategy - building blocks of automation systems.

UNIT-II	MOTION CONTROL IN AUTOMATION	07 Hours

Selection of motor for automation system, sizing of servo motor for a specific application, importance of sizing, selection of mechanical components, load cycle definition, load inertia and torque calculations, selection of motors.

UNIT-III	PRECISION MOTION COMPONENTS	07 Hours

LM Guide ways, Ball screws, bearings, Types, Selection, from the manufacturer's catalogue based on the applications, fixing arrangements and assembly

UNIT-IV	MATERIAL HANDLING SYSTEMS	07 Hours

Overview of material handling equipment, AGVs, ASRS, grippers-types- design -selection, considerations in material handling system design, principles of material handling,

UNIT-V	BELT CONVEYORS	07 Hours

Information required for designing , angle of incline, belt conveyor elements, selection of belt, drive,

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greasing of idlers, Plow Vs Trippers, magnetic pulley, skirt boards, training of belt conveyors, weighing material in motion, shuttle belt conveyor, pinion –swivel arrangement, troughing, suspended idlers, belt cleaners, transfer of material from belt to belt, cover, safety protection at pulleys, belt speeds and widths, design of a belt conveyor, belt conveyor calculation, minimum pulley diameters, enclosures for conveyors, idler selection, conveyor belt troubles

UNIT-VI	**SYSTEM INTEGRATION**	**07 Hours**

Issues and systematic approaches, case study- integration of machine tending robot with a CNC machine, design and simulation using CIROS software, economics of automation systems design and implementation

Text Books:

T3. Mikell P Grover, "Automation Production Systems and Computer Integrated Manufacturing", Pearson education, New Delhi, 2001.

T4. Jacob Fruchtbaum, "Bulk Materials Handling Handbook", CBS Publishers & Distributors, New Delhi, 1997.

Reference Books:

R4. Devadas Shetty, "Mechatronics System design", PWS Publishing Company, USA 2010.

R5. Wilfried Voss, " A comprehensible Guide to servo motor sizing", Copperhill Technologies Corporation.

R6. Conveyor Equipment Manufacturers Association, "Belt Conveyors for Bulk Materials", CBI Publishing Company, Massachusetts, 1979.

R4. HIWIN Linear Guide way – Technical Information Index.

On-Line resources:

1. Design for automation in manufacturing systems and processes (mit.edu)
2. Principles of Design for Automated Manufacturing - Fresh Consulting
3. Automation Design & Industrial Controls Engineering (epicindustrialautomation.com)

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Final practical examination for specific practical and oral examination will be conducted

List of Laboratory Assignments/Experiments

1.	Co-ordinated motion of multiple pneumatic actuators in a desired sequence using Cascade method.
2.	Integration of fringe condition modules in multiple actuator pneumatic systems.
3.	Co-ordinated motion of multiple actuators, electro – pneumatic systems in a desired sequence using hard – wire programmed control systems.
4.	Co-ordinated motion of multiple actuators, electro – pneumatic systems in a desired sequence using PLC.
5.	Interfacing of an LVDT with a PC for monitoring the displacement of machine slide and raising an alarm if the displacement exceeds specified limit.
6.	Inspection using Machine vision System

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7.	Control of speed, direction and number of revolutions of a stepper motor using PC.
8.	Development of an obstacle avoidance robot using servo motors, ultrasonic and touch sensors.

List of Course Seminar Topics:

1. Gear Design
2. Transfer of Assembly mechanism
3. Motor Design for Automation system
4. Belt Conveyor Design

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -VI
[AR3113A]: Elective II
Wireless Sensors Networks for Robotics

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH:03	In Sem. Evaluation:15 Marks Mid Sem. Exam: 25 Marks End Sem. Exam : 60 Marks

Course Prerequisites: Knowledge of basic electronics and Robots

Course Objective:

- To know the basic knowledge about wireless sensor networks
- To impart knowledge in networking using sensors
- To know about the tools used in networking
- To understand the basic in wireless architecture
- To know about the different techniques used in networking

Course Outcome:

After successful completion of the course, students will able to:

CO1: Ability to know about the different techniques used in networking
CO2: To expose basic knowledge about wireless sensor networks
CO3: Ability to know about the tools in networking
CO4: Understand the basic in wireless architecture.
CO5: Ability to know about the protocols used in networking

Course Contents

UNIT-I	Overview of Wireless Sensor Networks	08 Hours
Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks.		
UNIT-II	**Architecture Of Wireless Sensor Networks**	**07 Hours**
Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture -Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.		
UNIT-III	**Networking Sensors**	**07 Hours**
Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols-Energy-Efficient Routing, Geographic Routing.		
UNIT-IV	**Infrastructure Establishment**	**07 Hours**
Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control		
UNIT-V	**Sensor Network Platforms and Tools**	**07 Hours**
Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms,		

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Node-level Simulators, State-centric programming		
UNIT-VI	**Mobile Robot**	**07 Hours**
Network configuration for the Robots monitoring and Control system, Application-layer protocols		

Text Books:

T1. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.

T2. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

Reference Books:

R1. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.

R2. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -VI
[AR3113B]: Elective II
Industrial Internet of Things and Its Applications

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH: 03	In Sem. Evaluation:15 Marks Mid Sem. Exam: 25 Marks End Sem. Exam : 60 Marks

Course Pre requisites: Probability theory, field theory and random signal probability distribution

Course Objective:

Introduce the principles and applications of information theory. To teach study how information is measured in terms of probability and entropy, and the relationships among conditional and joint entropies. To teach coding schemes, including error correcting codes. To develop an understanding of different components of computer networks, various protocols, modern technologies and their applications.

Course Outcome:

After successful completion of the course, students will able to:

CO1: Describe source coding techniques in data compression and loss of information in channel.
CO2: Calculate the channel capacity and identify error correcting and detecting capabilities using different block codes.
CO3: Explain Galois field and related basics and evaluate cyclic codes and encoder-decoder circuit.
CO4: Examine multiple error correcting codes such as, BCH and RS code.
CO5: Establish multiple error correcting codes such as convolution code and Trellis coded modulation.
CO6: Summarize fundamental principles of data communication and networking.

Course Contents

UNIT-I	Information Theory & Source Coding	08 Hours

Introduction to information theory, Entropy and its properties, Source coding theorem, Huffman coding, Shannon-Fano coding, The Lempel Ziv algorithm, Run Length Encoding, Discrete memory less channel, Mutual information, Examples of Source coding-Audio and Video Compression.

UNIT-II	Information Capacity & Channel Coding	07 Hours

Channel capacity, Channel coding theorem, Information Capacity theorem, Linear Block Codes: Syndrome and error detection, Error detection and correction capability, Standard array and syndrome decoding, Encoding and decoding circuit, Single parity check codes, Repetition codes and dual codes, Hamming code, Golay Code, Interleaved code.

UNIT-III	Cyclic Codes	08 Hours

Primitive element & Primitive polynomial, Minimal polynomial and generator polynomial, Description of Cyclic Codes, Generator matrix for systematic cyclic code, Encoding for cyclic code, Syndrome decoding of cyclic codes, Circuit implementation of cyclic code.

UNIT-IV	BCH and RS Codes	07 Hours

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Binary BCH code, Generator polynomial for BCH code, Decoding of BCH code, RS codes, generator polynomial for RS code, Decoding of RS codes, Cyclic Hamming code and Golay code.		
UNIT-V	**Convolutional Codes**	**07 Hours**
Introduction of convolution code, Polynomial description of convolution code, Generator Matrix of convolution code, State diagram, Tree diagram, Trellis diagram, Sequential decoding and Viterbi decoding , Known good convolution code, Trellis Coded Modulation, Turbo code.		
UNIT-VI	**Data Communication & Physical Layer**	**07 Hours**
Data Communications – Networks - Network models – OSI model – Layers in OSI model – TCP / IP protocol suite – Addressing – Guided and Unguided Transmission media. Fiber optic networks, light wave transmission, communication satellites.		

Text Book:

T1. Bernad Sklar, ―Digital Communication Fundamentals & applications‖, Pearson Education. Second Edition

T2. Behrouz A. Foruzan, ―Data communication and Networking‖, Tata McGraw-Hill

Reference Books:

R1. Ranjan Bose," Information Theory coding and Cryptography", Mc Graw-Hill. 2nd Ed

R2. Murlidhar Kulkarni, K.S. Shivaprakasha," Information Theory & Coding", Wiley Publications

R3. Simon Haykin, "Communication Systems", John Wiley & Sons, Fourth Edition.

R4. Shu Lin and Daniel J. Costello Jr., "Error control Coding" Pearson, 2nd Edition.

On-Line resources:

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -VI
[AR3113C]: Elective II
Additive Manufacturing

Teaching Scheme:	Credit	Examination Scheme:
TH: 03Hours/Week	TH:03	In Sem. Evaluation:15 Marks Mid Sem. Exam: 25 Marks End Sem. Exam : 60 Marks

Course Prerequisites: Material Science and Engineering, Manufacturing Technology and Metrology

Course Objective:

- To educate about development and manufacturing of component using additive manufacturing processes.
- To educate about principle, methods, possibilities, and limitations as well as environmental effects of Additive Manufacturing technologies.
- To identify the characteristics of the different materials those are used in Additive Manufacturing technologies.
- To educate about creating physical objects that satisfy product development/prototyping requirements

Course Outcome:

After successful completion of the course, students will able to:

CO 1: Explain the fundamentals of Additive Manufacturing Technologies for engineering applications.
CO 2: Apply techniques of CAD and reverse engineering for geometry creation and transformation.
CO 3: Explain the methodology to manufacture the products using Liquid and Solid additive manufacturing technologies and study their applications, advantages.
CO 4: Explain the methodology to manufacture the products using powder based additive manufacturing technologies and study their applications, advantages.
CO 5: Explain the methodology to manufacture the products using inkjet (droplet) based deposition and fusion additive manufacturing technologies and study their applications, advantages.
CO 6: Discuss real-life applications for additive Manufacturing

Course Contents

UNIT-I	Introduction to Additive Manufacturing	08 Hours

Introduction to AM, Historical Development, Additive v/s Conventional Manufacturing, Role of AM in Product development cycle, Rapid prototyping, Relevance of AM in Industry 4.0, Current industry and manufacturing trends driving AM, AM Process-Chain, Reverse engineering, Advantages, Types of materials, Classification of AM Processes (Process-based, material form based, application-based - direct and indirect processes and Micro- and Nano-additive processes), Process Planning for Additive Manufacturing.

UNIT-II	Reverse Engineering and CAD Modelling	08 Hours

Conventional use of Reverse Engineering Procedure, Digitization Methods, Measuring Devices: Classification and Types, Advantages, Disadvantages, Limitations 3D Scanning: Scanning Process ,3D

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Scanners(Classification and Types,) Software: Medical image control system software, Engineering Scanning and Data Conversion Software CAD Model Construction: Point Clouds Data, Pre-processing, Point Clouds to Surface Model Creation, Classification and Types, NURBS surface model generation and its software use, Medical Data Processing, Data Handling and Reduction Methods Scanned Geometry Refinement: Smooth the Surface, Remove Bumps and Blobs, Clean-up, Repair, other relevant Techniques

UNIT III	**Liquid And Solid Based Additive Manufacturing**	**08 Hours**

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations, and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses, and applications. Fused deposition Modelling (FDM): Principle, details of processes, process variables, types, products, materials, and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations, and applications - Case studies.

UNIT-IV	**Powder Based Additive Manufacturing**	**08 Hours**

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations, and applications– Case Studies.

UNIT-V	**Inkjet(Droplet) Based Deposition and Fusion Technologies**	**08 Hours**

Process and mechanism, Materials, Process Physics, Parameters, Benefits, Drawbacks, Limitations and Applications of Inkjet(droplet)-Based Deposition and Fusion: Multi-jet Modeling (MJM), Polyjet Printing, Nanoparticle Jetting, Binder Jetting, Multi-Jet Fusion, Color-jet Printing (CJP), Energy Deposition Techniques: Plasma/TIG/MIG/Arc Deposition, Electron Beam-based DED, Direct Metal Deposition (DMD), 3D Laser Cladding.

UNIT-VI	**Application of Additive Manufacturing- Case Studies**	**08 Hours**

Case Studies and Application of AM: 3D printing in prominent industries (Aerospace, Electronics, Defense, Automotive, Construction, Architectural, Machine-Tools), Other industrial applications (Health-Care, Personalized Surgery, Bio-medical Applications, Assistive Devices, Food-Processing, Food & Consumer Applications, Art, Fashion, Jewelry, Toys & Other Applications, etc.), Special Topics:4D/5D Printing, Bio-printing, Bio-materials, scaffolds and tissue and Organ Engineering, Mass Customization and Future trends.

Text Books:

T1. Amit Bandyopadhyay, Susmita Bose, “Additive manufacturing”, CRC Press, Taylor & Francis Group, 2016.

T2. Ian Gibson, David W. Rosen, Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer, 2010.

Reference Books:

R1. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, second edition, World Scientific Publishers, 2010.

R2. Ben Redwood, Filemon Schöffer & Brian Garret, “The 3D Printing Handbook – Technologies, Design and Applications” Part One:3D Printing Technologies and Materials, 3D Hubs, 2017

R3. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.

R4. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

R5. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.

R6. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A toolbox for prototype development”, CRC Press, 2011.

R7. Andreas Gebhardt and Jan-Steffen Hötter, "Additive Manufacturing: 3D Printing for Prototyping and

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Manufacturing" Hanser Publishers, Munich, 2016.
R8. Bill Macy, " Reverse Engineering for Additive Manufacturing", Handbook of Manufacturing Engineering and Technology, Springer, 2014

On -Line Resources:

1. https://onlinecourses.nptel.ac.in/noc22_me122/preview
2. https://onlinecourses.nptel.ac.in/noc20_mg70/preview
3. https://onlinecourses.nptel.ac.in/noc22_me130/preview

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -VI
[AR3114]: Programming with Python

Teaching Scheme: LAB:02Hours/Week	Credit PR: 01	Examination Scheme: LAB Evaluation: 50 Marks

Course Prerequisites: C programming

Course Objective:

This course introduces core programming basics—including data types, control structures, algorithm development, and program design with functions—via the Python programming language. The course discusses the fundamental principles of Object-Oriented Programming, as well as in-depth data and information processing techniques. Students will solve problems, explore real-world software development challenges, and create practical and contemporary applications

Course Outcome:

After successful completion of the course, students will be able to,

CO1: Student should be able to understand the basic concepts scripting and the contributions of scripting language

CO2: Ability to explore python especially the object-oriented concepts, and the built-in objects of Python.

CO3: Ability to create practical and contemporary applications such as TCP/IP network programming, Web applications, discrete event simulations.

Lab Contents

Guidelines for Assessment

Practical/Oral examination based on the practical's performed in the lab. The Performance will be assessed jointly by internal and external examiners.

- Total marks assigned are 50.
- Continuous assessment will be carried out based on attendance, lab performance, and timely submission of lab file
- Final practical examination for specific practical and oral examination will be conducted

List of Laboratory Assignments/Experiments

1	Syntax basics, Arithmetic/String Operations, Input/Output
2	Control Flow constructs: If-else, Relational and Logical Operators
3	Iteration: While loop, For loop.
4	Collections: Lits, Tuples
5	Collections: Sets, Dictionary
6	Functions and Modules: sys, math, time
7	File Handling: Data streams, Access modes, Read/Write/Seek
8	Exception handling: hierarchy, raise, assert
9	OOP: Classes, Objects

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10	GUI programming: TkInter

Text Books

T1: Exploring Python, Timothy Budd, Mc Graw Hill Publication, ISBN: 9780073523378, August 2010.

T2: Beginning Python, Peter C. Norton, Alex Samuel, Dave Aitel, Eric Foster-Johnson, Leonard Richardson, Jason Diamond, Aleatha Parker, Michael Roberts, ISBN: 978-0-7645-9654-4, August 2005.

Reference Books:

R1: Python: Create - Modify - Reuse, James O. Knowlton, Wrox Publication, ISBN: 978-0-470- 25932-0, July 2008.

R2: Professional Python Frameworks: Web 2.0 Programming, Dana Moore, Raymond Budd, William Wright, Wrox Publication, ISBN: 978-0-470-13809-0, October 2007.

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2023-2024 Semester -VI
[AR3115]: Audit Courses-IV

Teaching Scheme: -	**Credit : -**	**Examination Scheme: -**

List of Courses to be opted (Any one) under Audit Course IV

Code	**Name of Course**	**Link**
HS3107	Essence of Indian Knowledge Tradition -II	https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-2/ug-vol2.pdf
HS3109	Introduction to Human Factors and Ergonomics	https://onlinecourses.swayam2.ac.in/aic20_ed03/preview
HS3110	Mind Education	https://onlinecourses.swayam2.ac.in/aic19_as05/preview

GUIDELINES FOR CONDUCTION OF AUDIT COURS

A student shall be awarded the bachelor's degree if he/she earns 170 credits and clears all the audit courses specified in the syllabus. The student shall be awarded grade as AP (Audit Course Pass) on successful completion of audit course. The student may opt for one of the audit courses per semester, starting from second year first semester. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course shall be done. Method of conduction and method of assessment for audit courses are suggested.

Using NPTEL Platform:

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Student can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course.
- Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal.
- After clearing the examination successfully; student will be awarded with certificate.

Guidelines for Assessment:

The assessment of the course will be done at the institute level. The department has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary.

- During the course students will be submitting the online assignments. A copy of same students can submit as a part of term work for the corresponding Audit course.
- On the satisfactory submission of assignments, the institute can mark as "Present" and the student will be awarded the grade AP on the marksheet.

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